

A First Look at the Radiative Impact of Cirrus Encountered During C-F

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C-F Deployment

- Flew identical solar spectral (SSFR) and broad-band infrared (CG-4) sensors on the ER-2 and Twin Otter.
- Measured upwelling and downwelling solar spectral and broadband infrared irradiance

Objectives

- characterize the top of column (tropopause) and lower troposphere radiation fields
- infer cloud thermodynamic phase, optical thickness, and effective particle size, ice/liquid water path
- cirrus radiative forcing and cirrus clear sky heating and cooling rates
- compare spectral fluxes with fluxes calculated from cirrus properties derived from the MODIS Airborne Sensor (MAS) and microphysics measured *in situ*

Today's talk ...

- some comparisons with CERES/CDC infrared flux; infrared flux profiles
- three cloud solar spectra case study dates: **7/9, 7/7, 7/23**
 - compare solar spectra w/ model
 - column (3-20 Km) solar spectral absorption
- relate cirrus solar and infrared properties

NASA Ames Solar Spectral Flux Radiometer (SSFR)

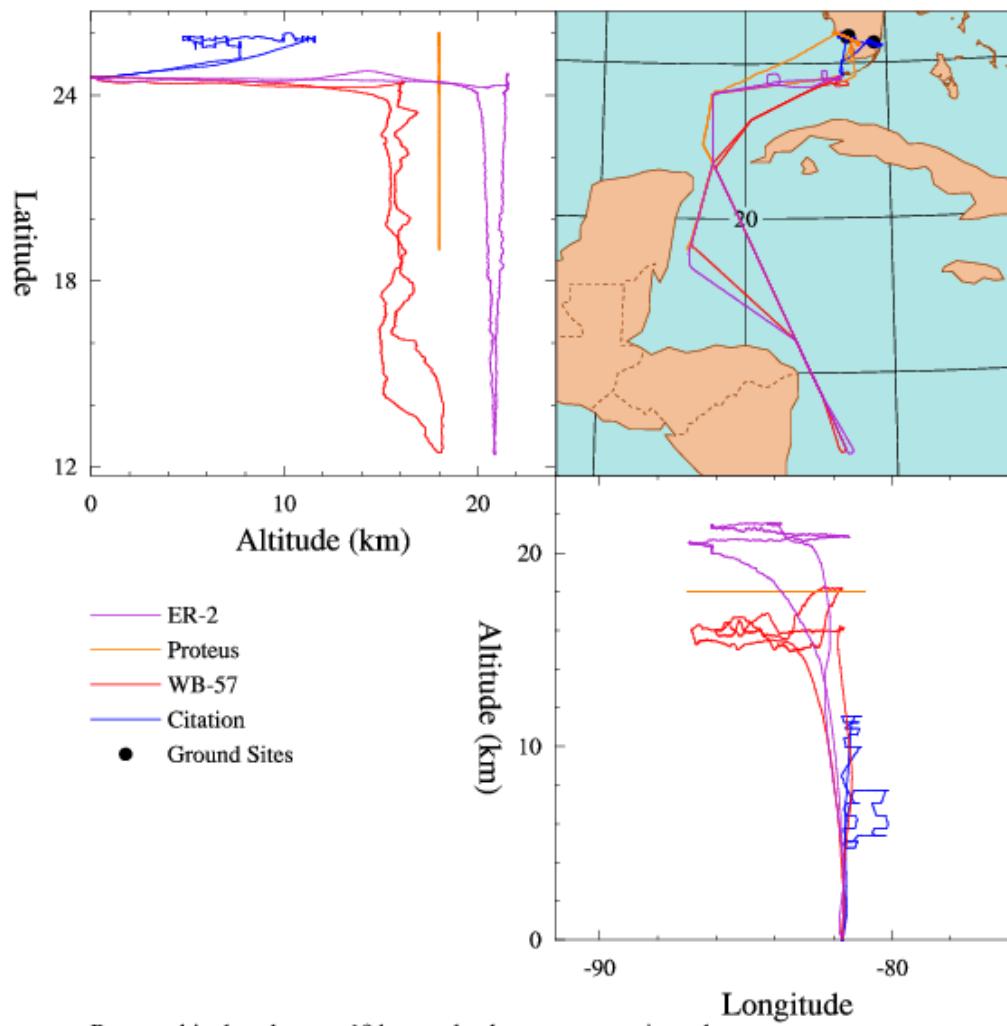
- wavelength range:
300 nm to 1700 nm
- spectral resolution ~
8-12 nm
- simultaneous zenith
and nadir viewing
- hemispheric FOV
- Accuracy: ~ 3%; precision: 0.5%
- Missions: FIRE/SHEBA, DOE ARM UAV (1999,
2000, 2002), PRIDE, SAFARI-2000, ACE-Asia,
CRYSTAL-FACE



NASA Ames Solar Spectral Flux Radiometer (SSFR)

- Measure Quantities: Upwelling ($F\uparrow$) and down-welling ($F\downarrow$) spectral Irradiance [$\text{W m}^{-2}\text{nm}^{-1}$]
- Derived Quantities
 - Spectral Albedo: $F\uparrow / F\downarrow$
 - Net Flux: $F\downarrow - F\uparrow$
 - Flux Divergence (absorption): $(F\downarrow - F\uparrow)_{\text{top}} - (F\downarrow - F\uparrow)_{\text{bottom}}$
 - Fractional absorption: $(F\downarrow - F\uparrow)_{\text{top}} - (F\downarrow - F\uparrow)_{\text{bottom}} / F\downarrow_{\text{top}}$
- Retrieved Quantities: cloud effective droplet radius, optical depth, water path [r_e , τ , LWP]; aerosol single scattering albedo, asymmetry parameter [ω_o , g]

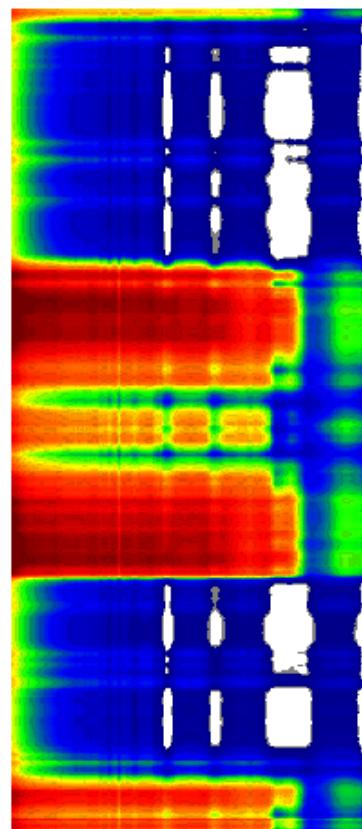
Flight tracks on 20020709



7/9/02

ER-2 SSFR Albedo

09 July 2002

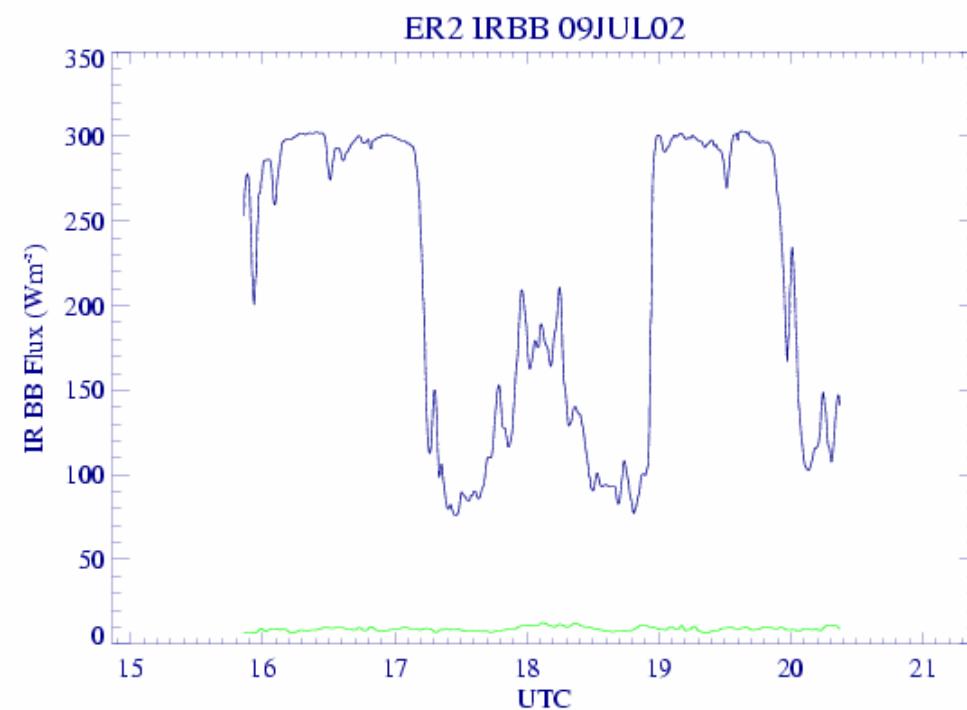


15:46 UTC

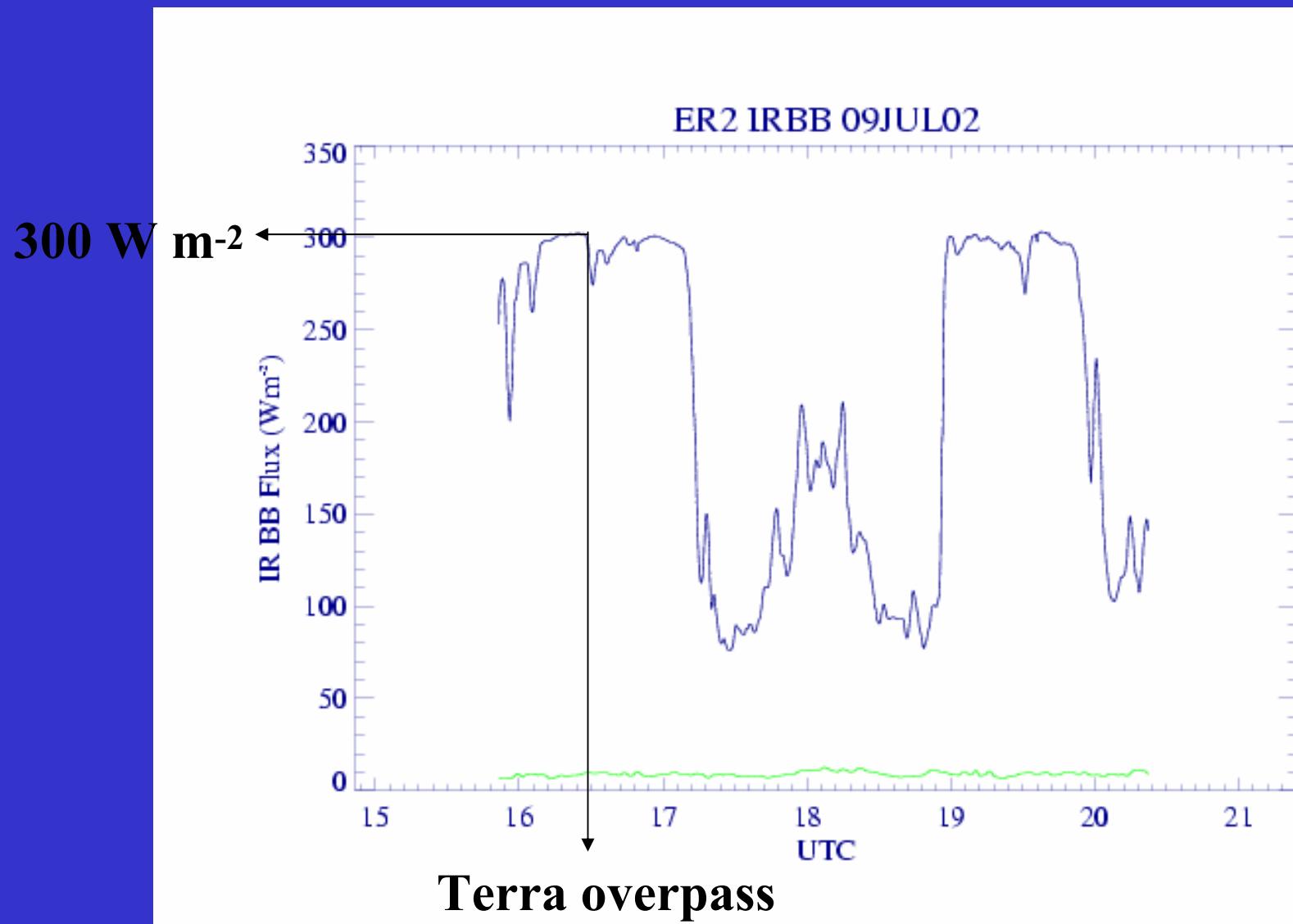
20:22 UTC

350 nm

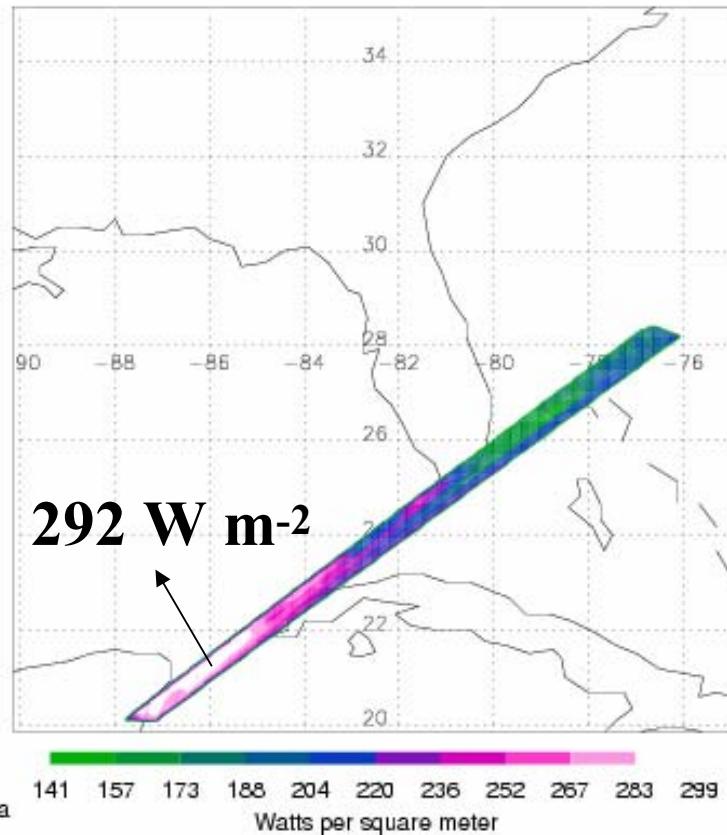
1700 nm



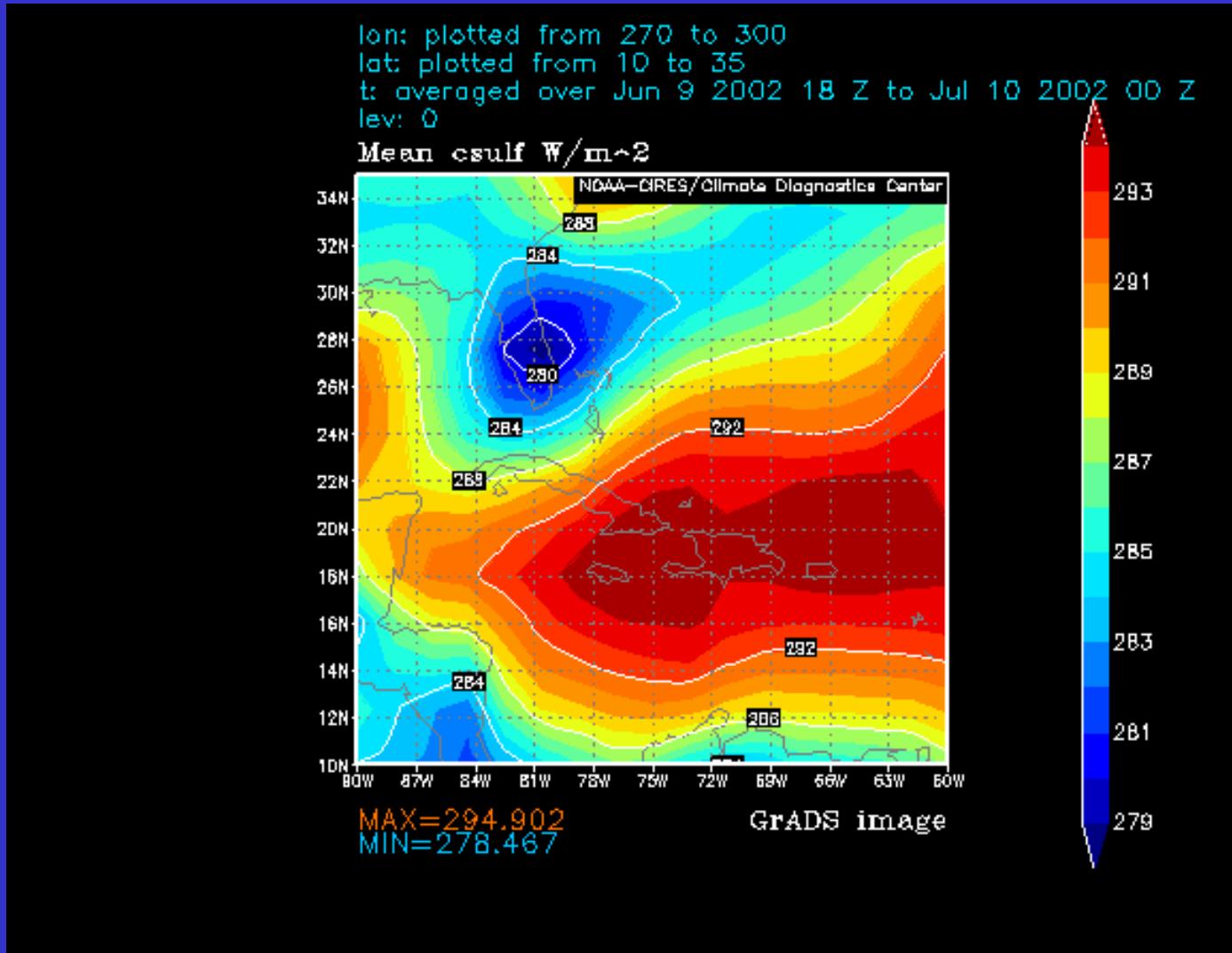
7/9/02: Infrared Broadband Flux



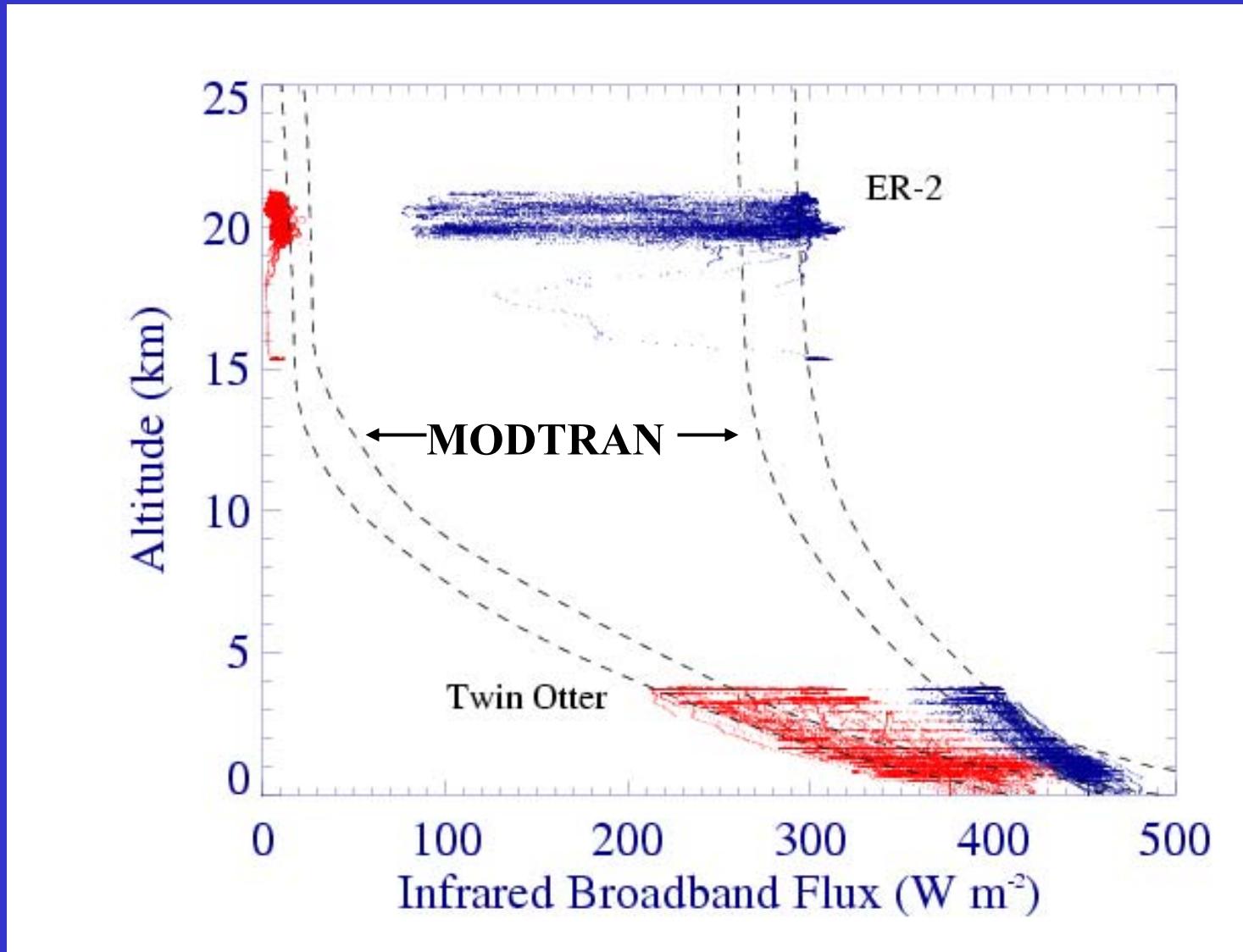
7/9/02: CERES OLR



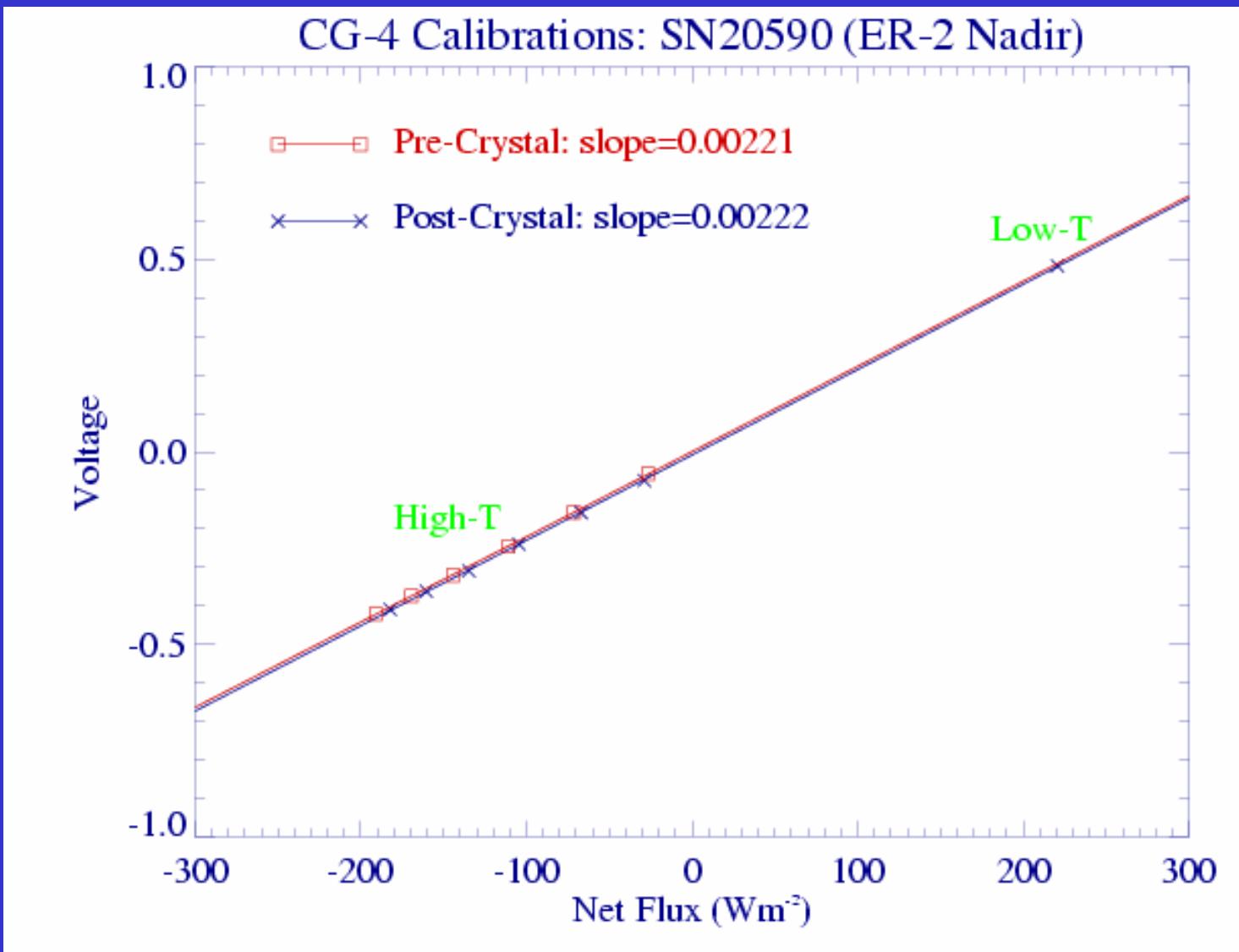
CDC CSULF



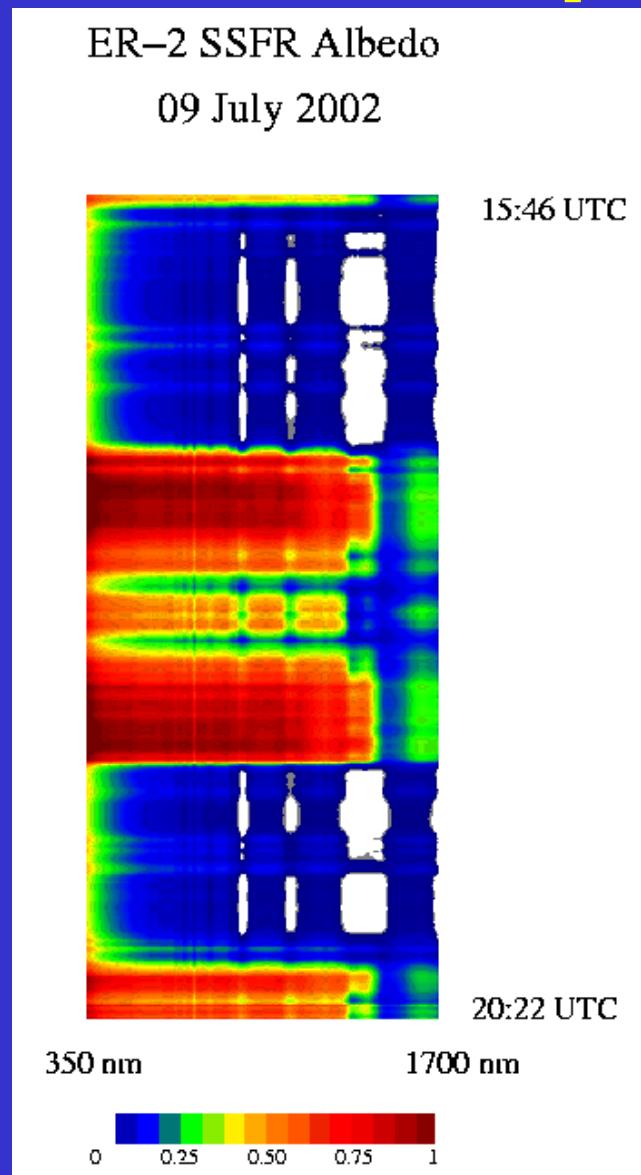
ER-2, TO, & MODTRAN IR FLUX



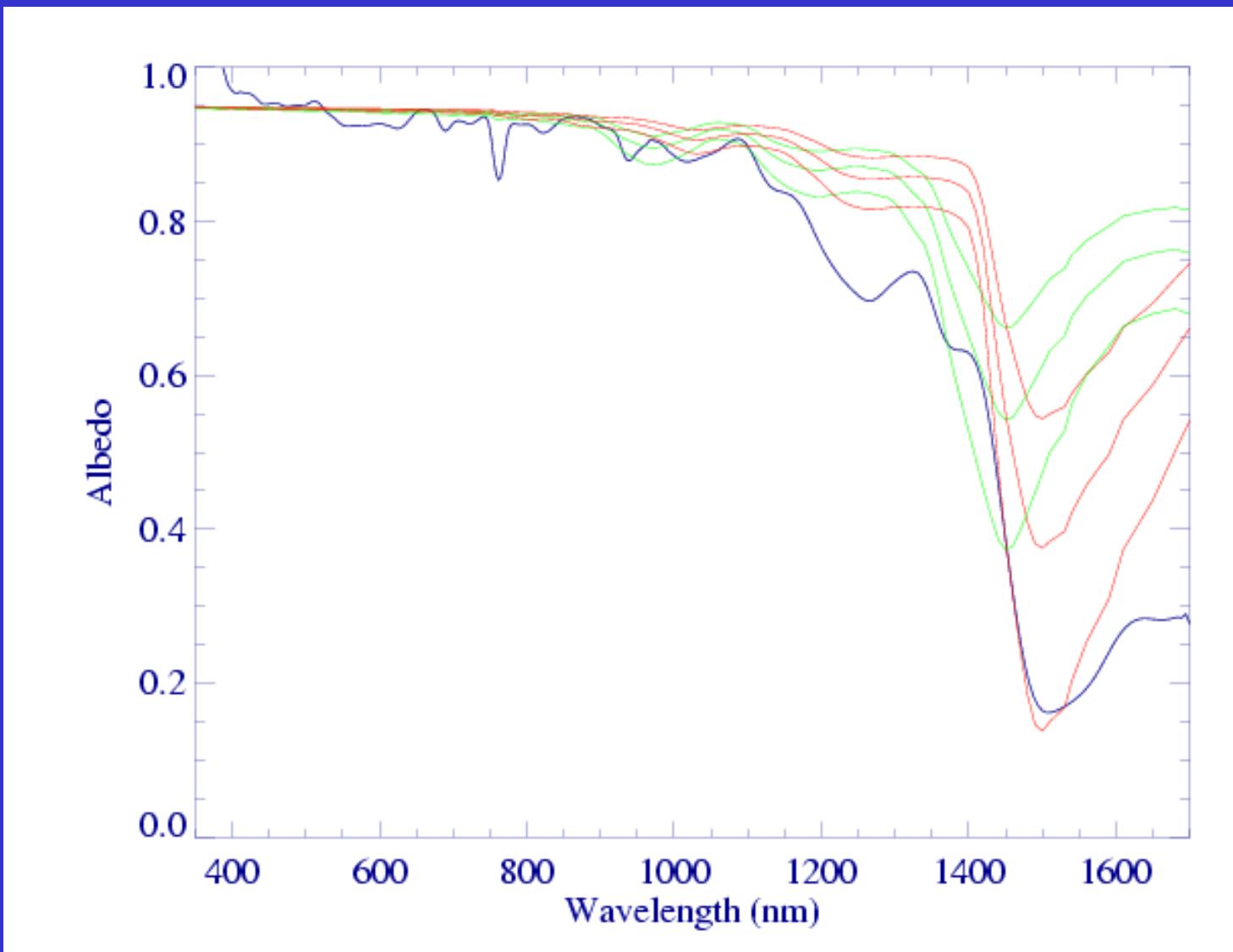
CG-4 Calibration



7/9/02: Solar Spectra



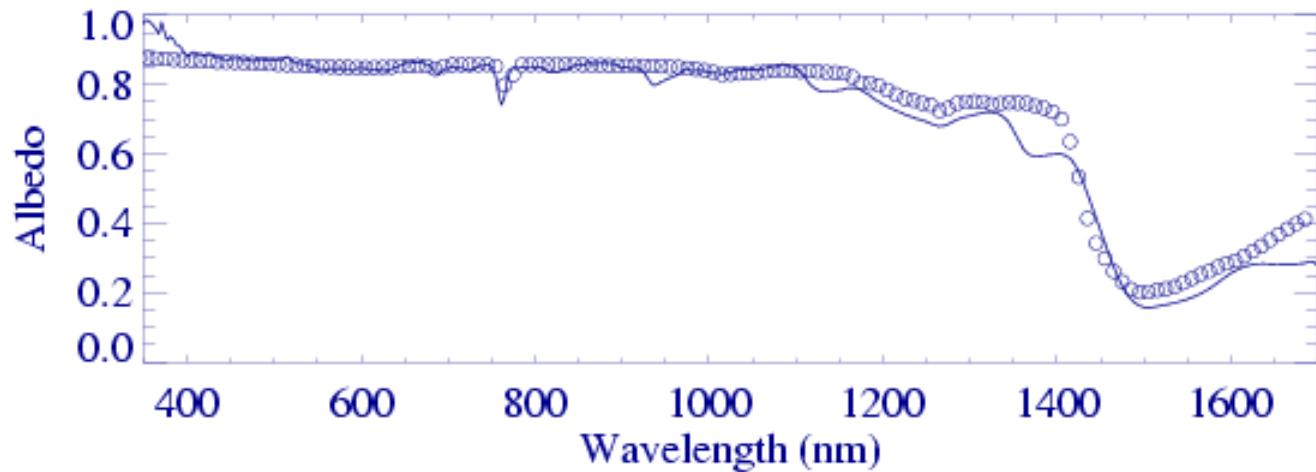
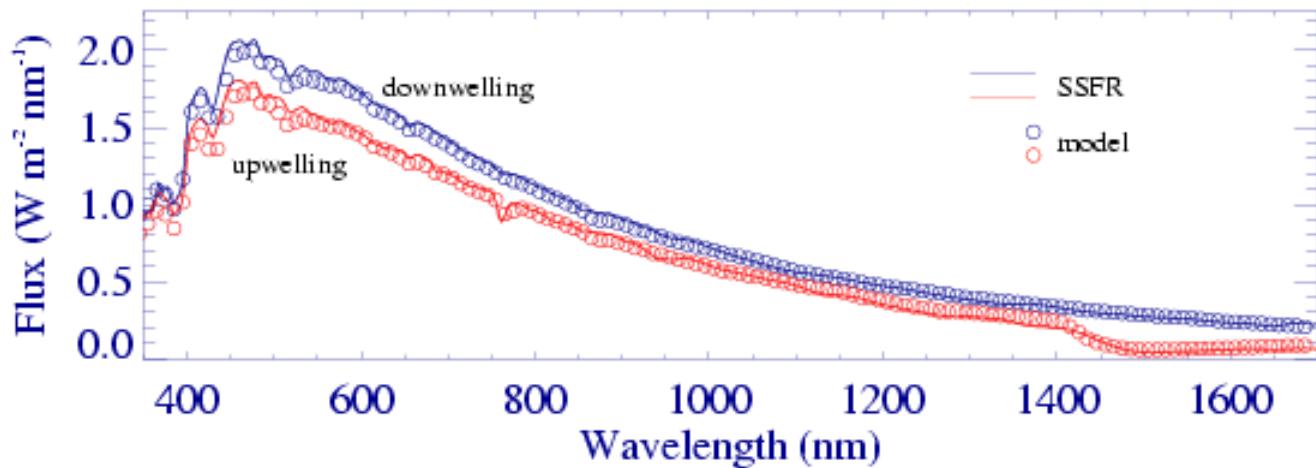
Ice vs Water Cloud Albedo



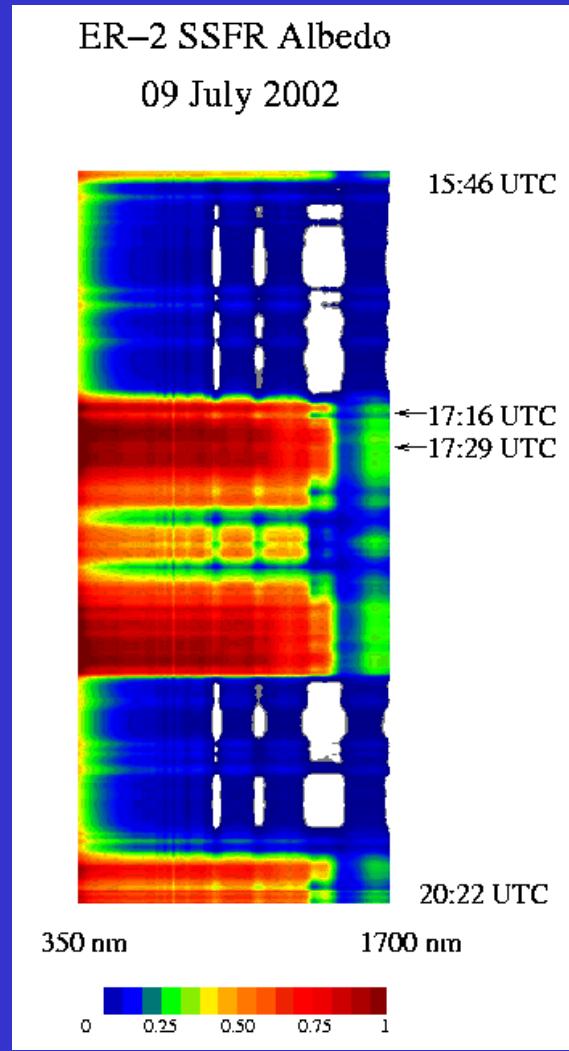
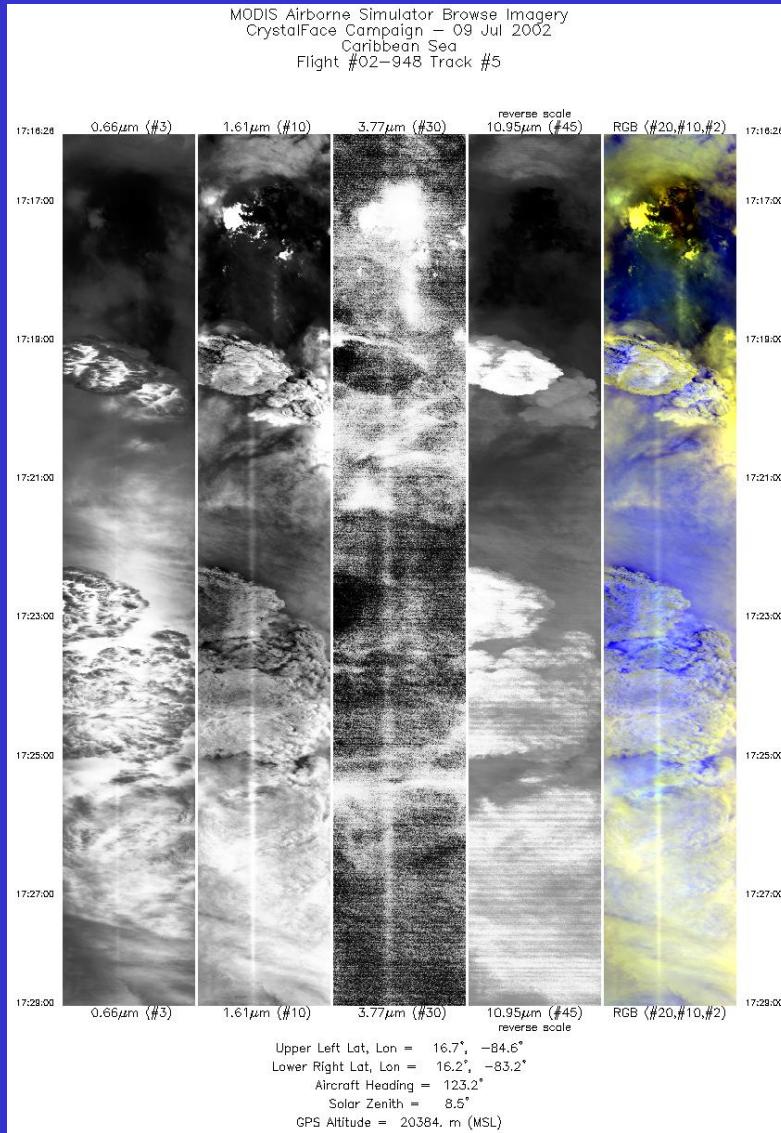
7/9/02: Solar Flux and Albedo

$$\tau = 80$$

$$d_e = 20 \mu m$$

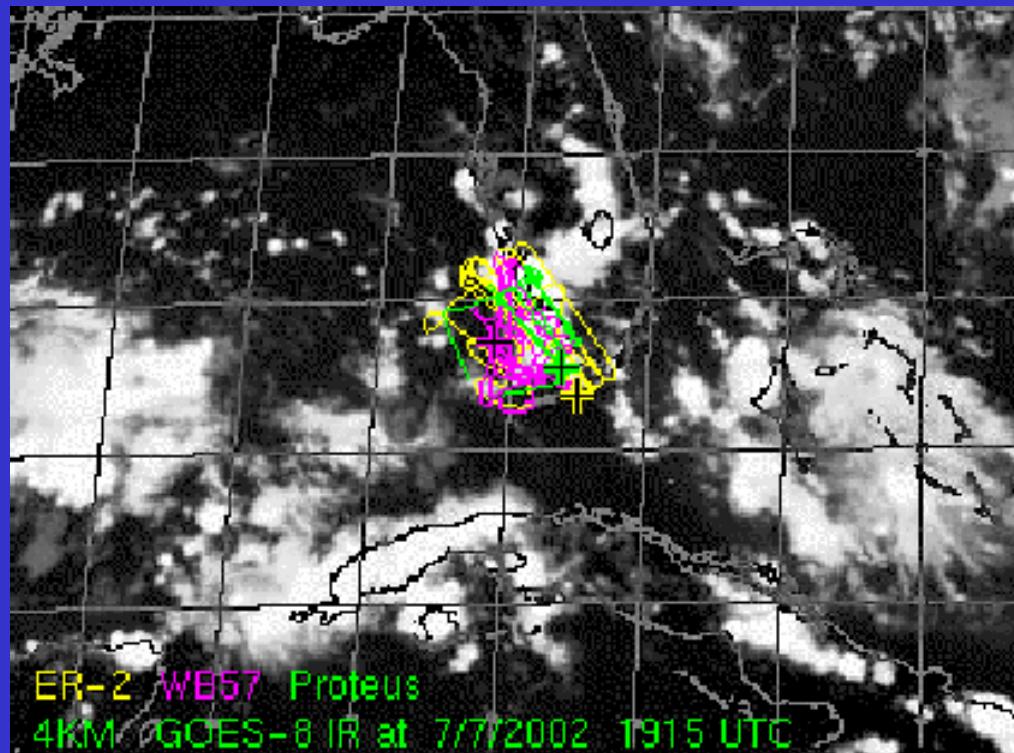
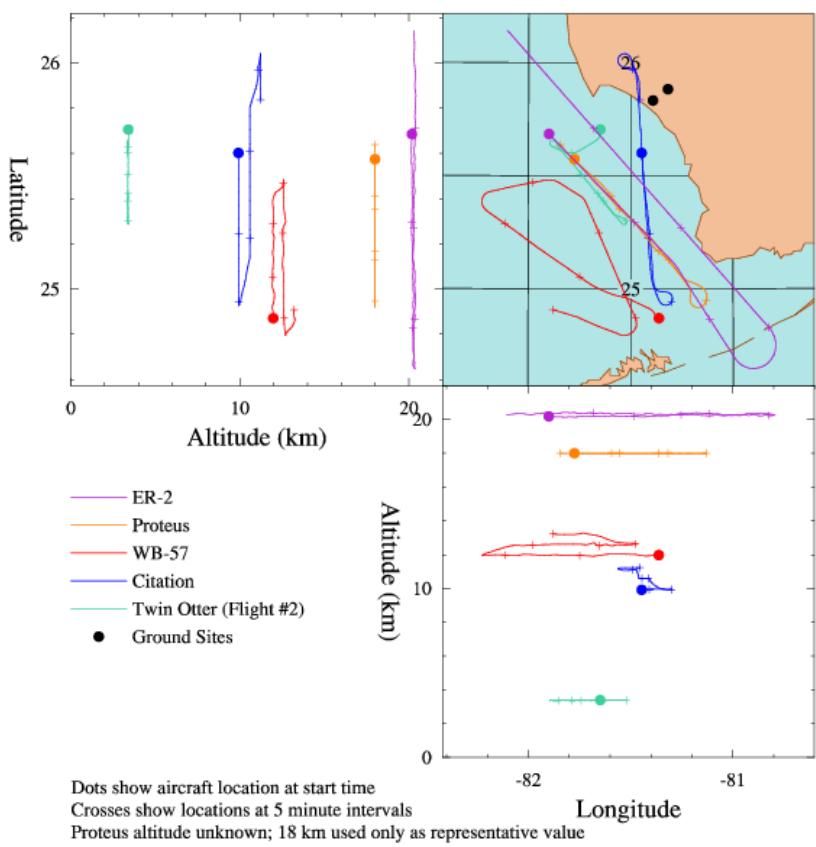


MAS and SSFR: 07/09/02



7/7/02

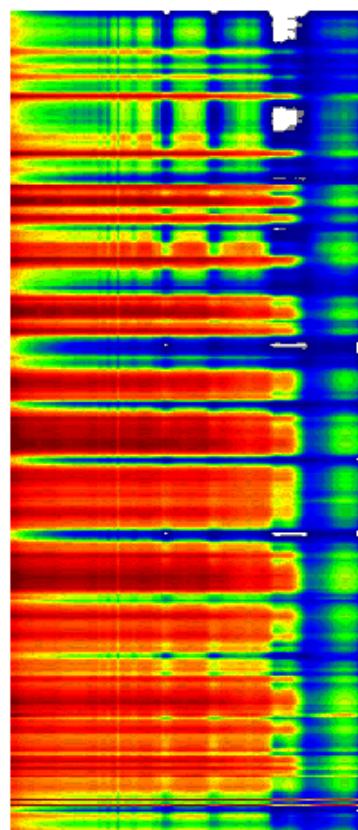
Flight tracks on 20020707 starting at 68400 UT (19:00)



7/7/02: ER-2 & TO SSFR

ER-2 SSFR Albedo

07 July 2002



350 nm

1700 nm



16:37 UTC

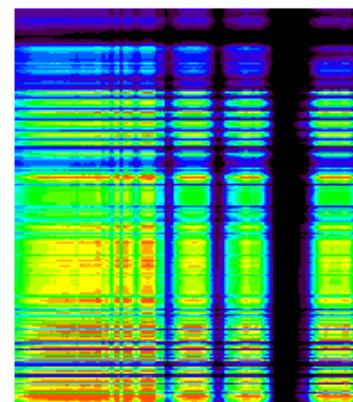
→ 19:00 UTC

→ 19:30 UTC

22:04 UTC

TO SSFR Transmittance

07 July 2002



12:33 UTC

15:13 UTC

17:31 UTC

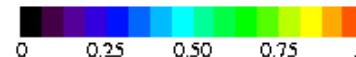
→ 19:00 UTC

→ 19:30 UTC

21:41 UTC

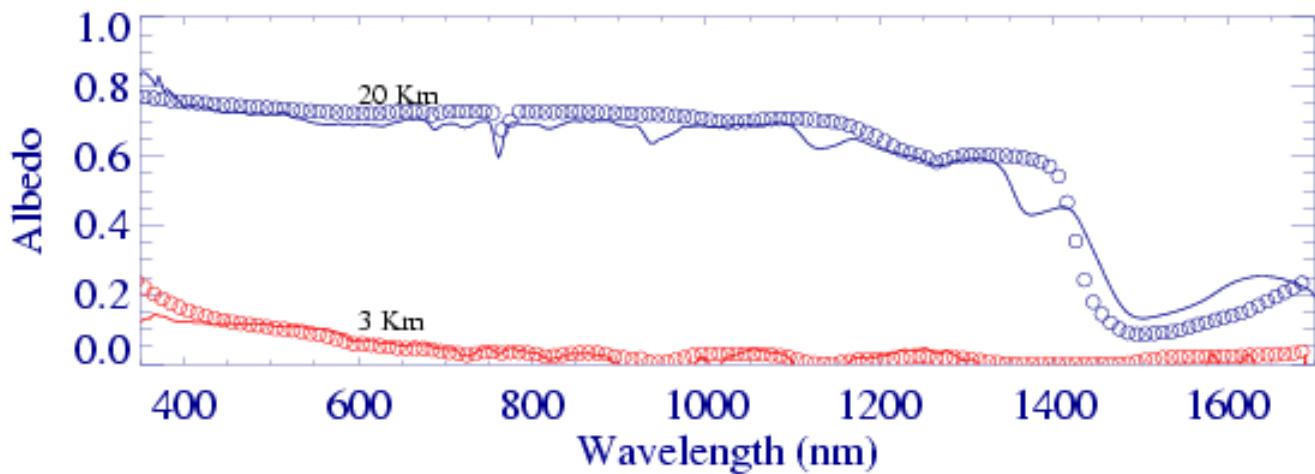
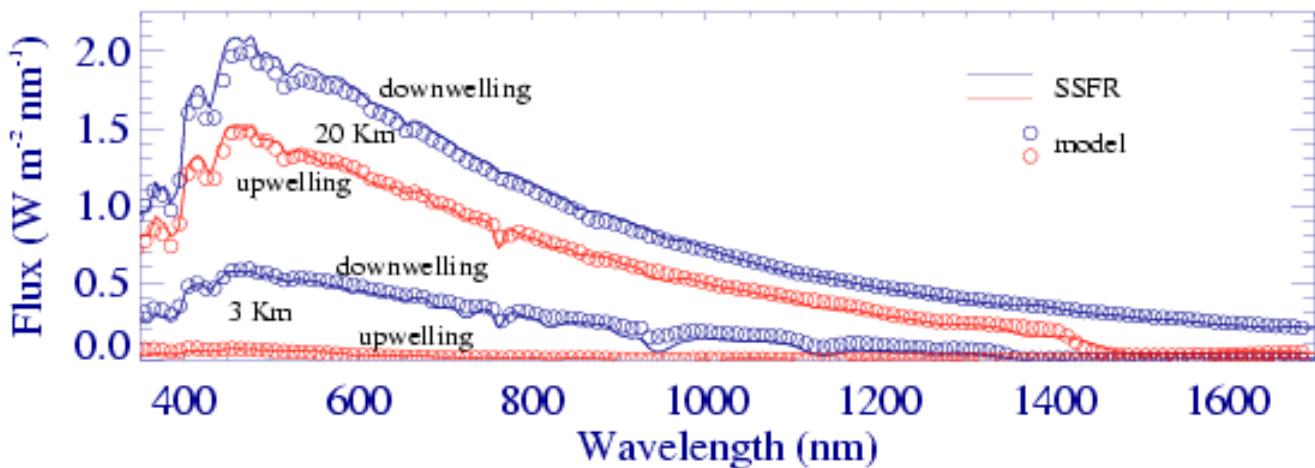
350 nm

1700 nm

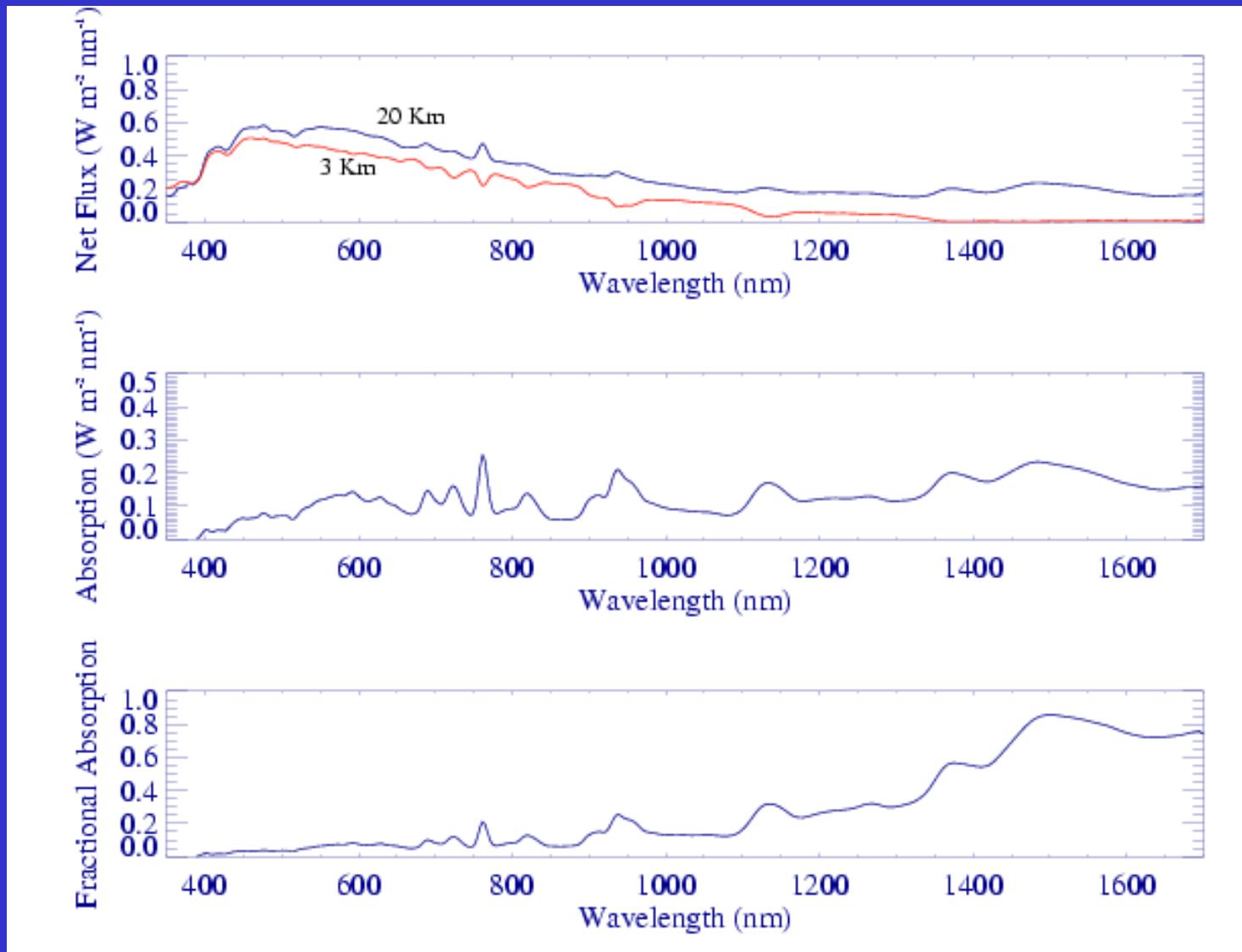


7/7/02: Solar Flux and Albedo

$$\begin{aligned}\tau &= 40 \\ d_e &= 50 \text{ } \mu\text{m}\end{aligned}$$

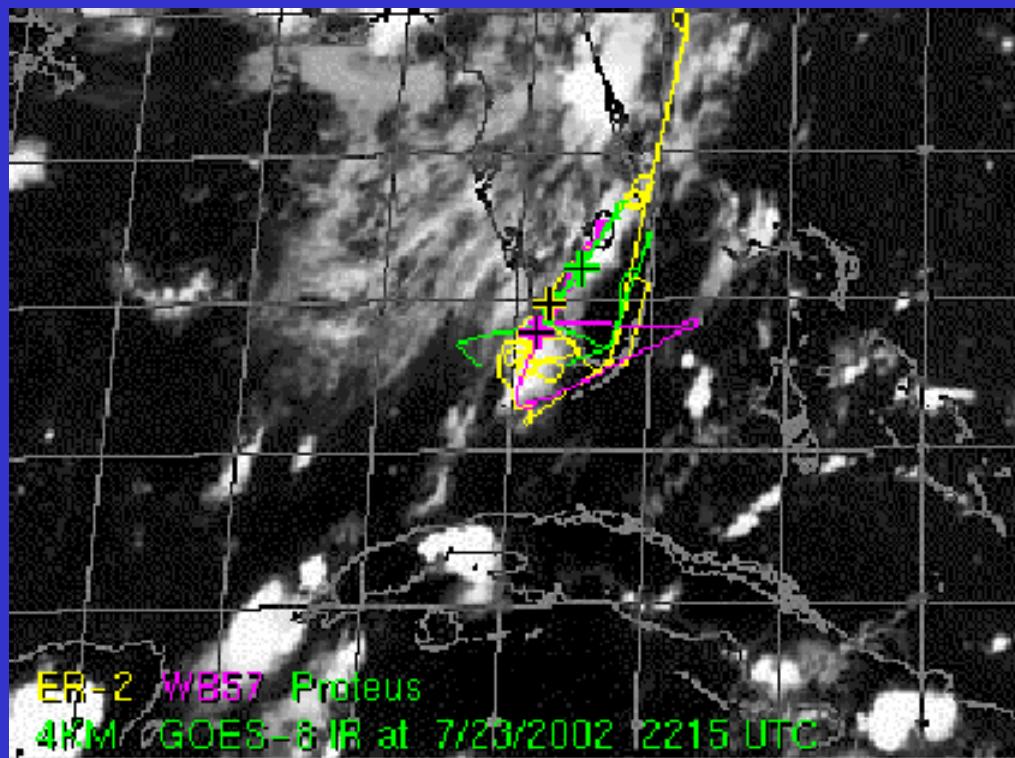
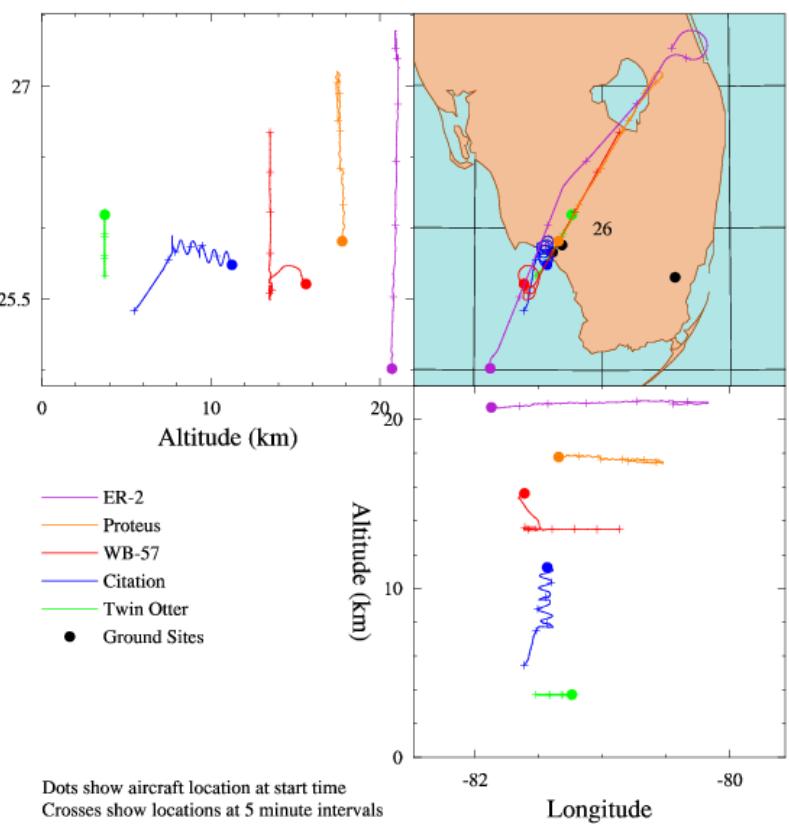


7/7/02: Net flux/Absorption



7/23/02

Flight tracks on 20020723 starting at 81000 UT (22:30)

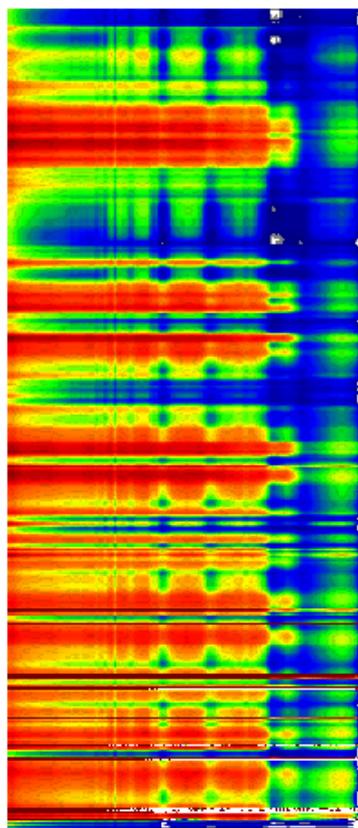


7/23/02: ER-2 & TO SSFR

ER-2 SSFR Albedo

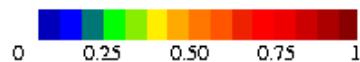
23 July 2002

17:53 UTC



350 nm

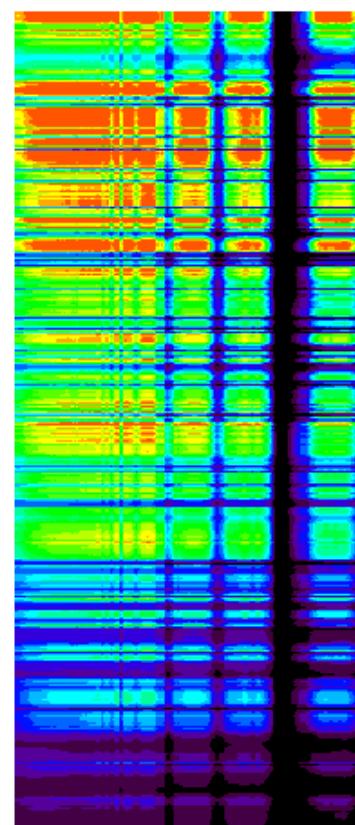
1700 nm



TO SSFR Transmittance

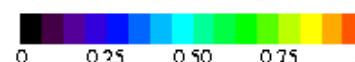
23 July 2002

19:33 UTC



350 nm

1700 nm



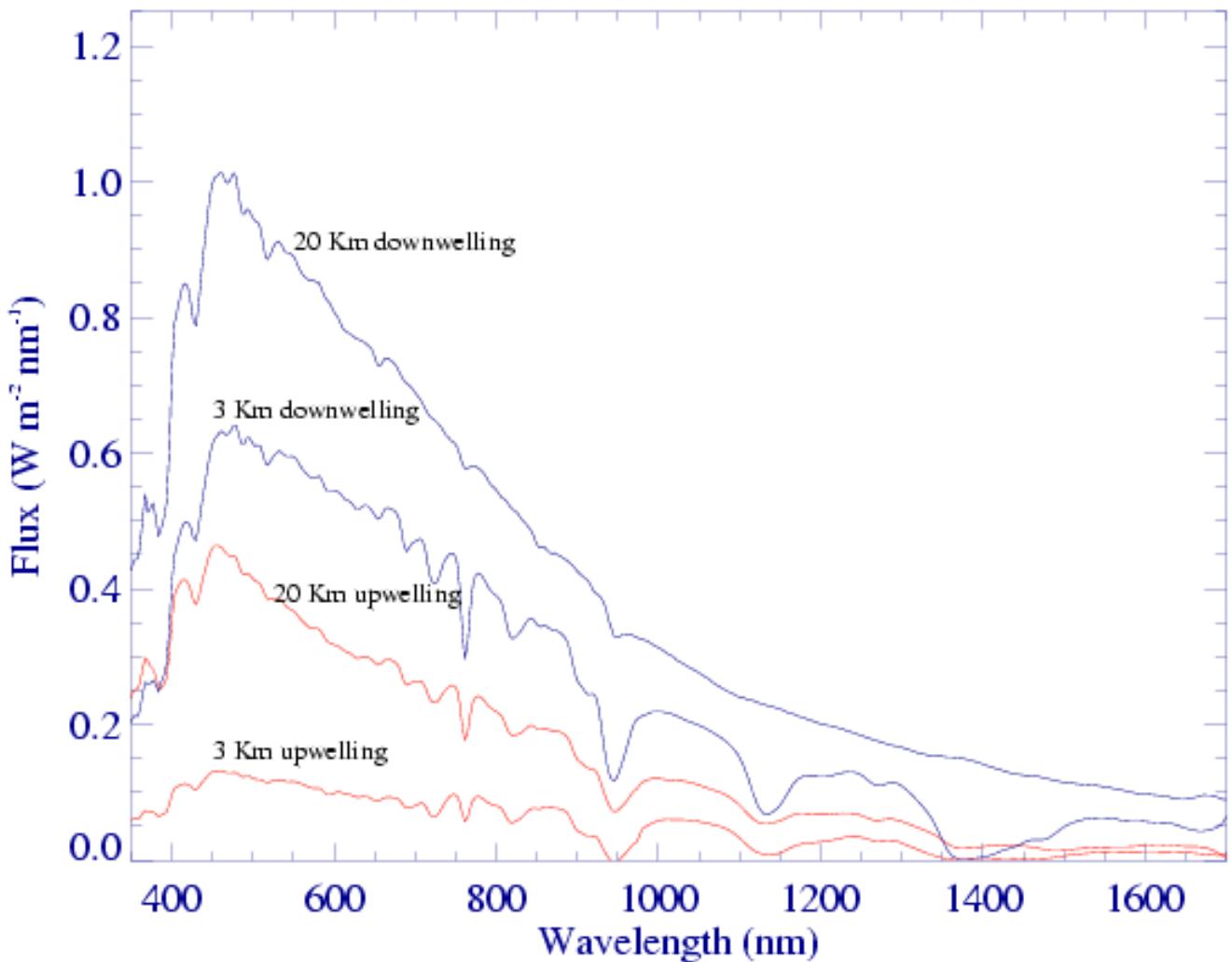
→ 22:30 UTC

→ 23:00 UTC

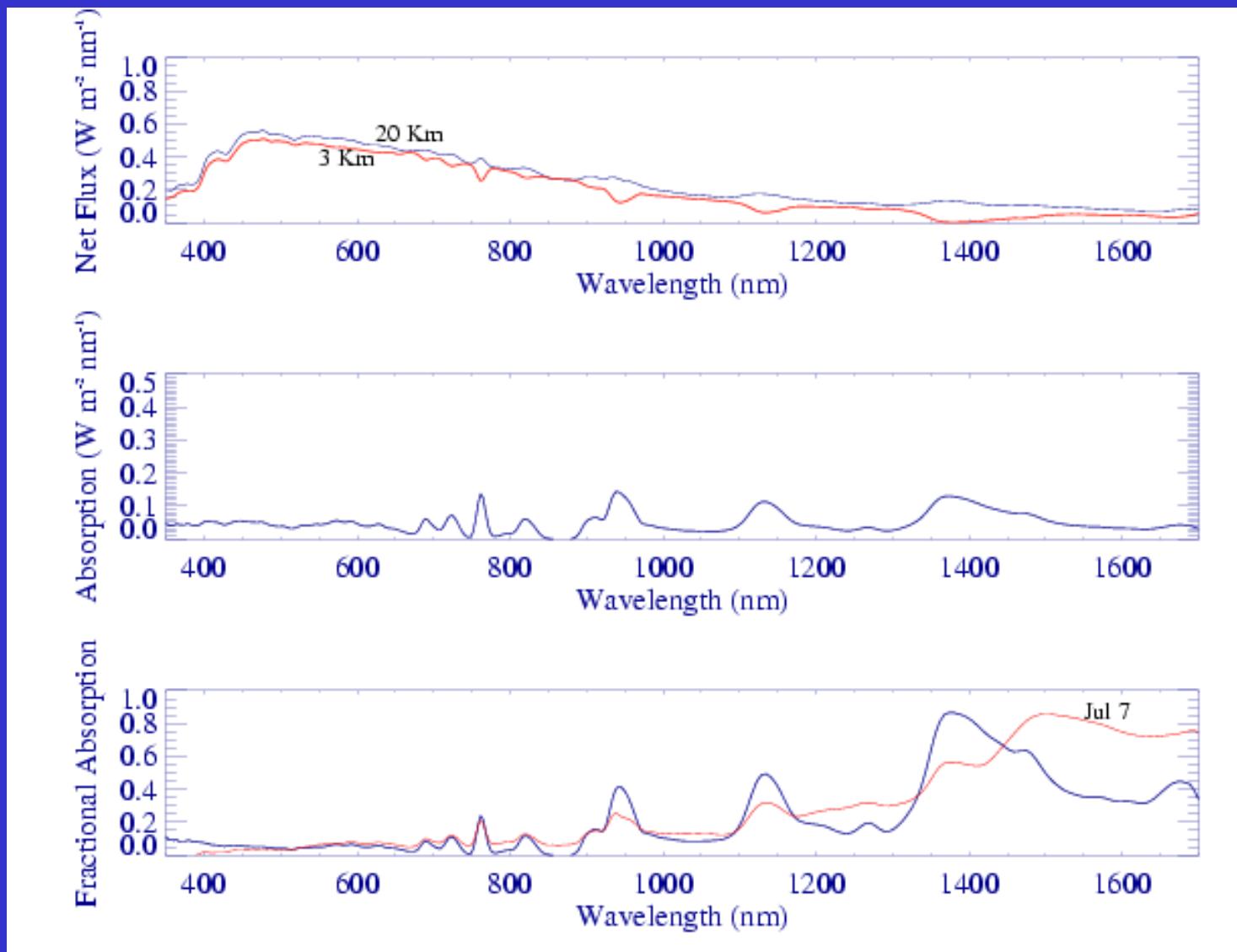
23:26 UTC

7/23/02: Solar Flux

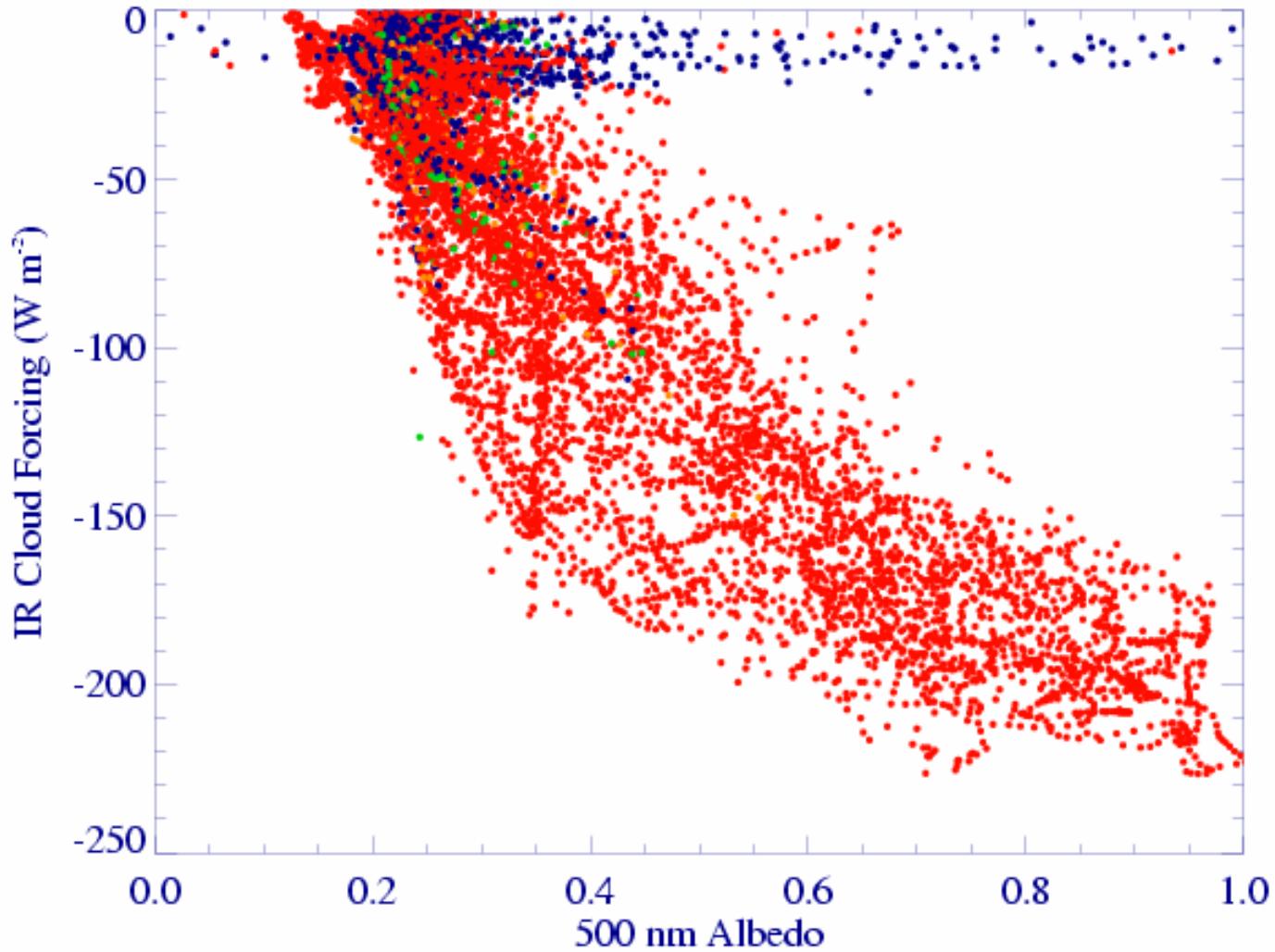
$\tau = 10$



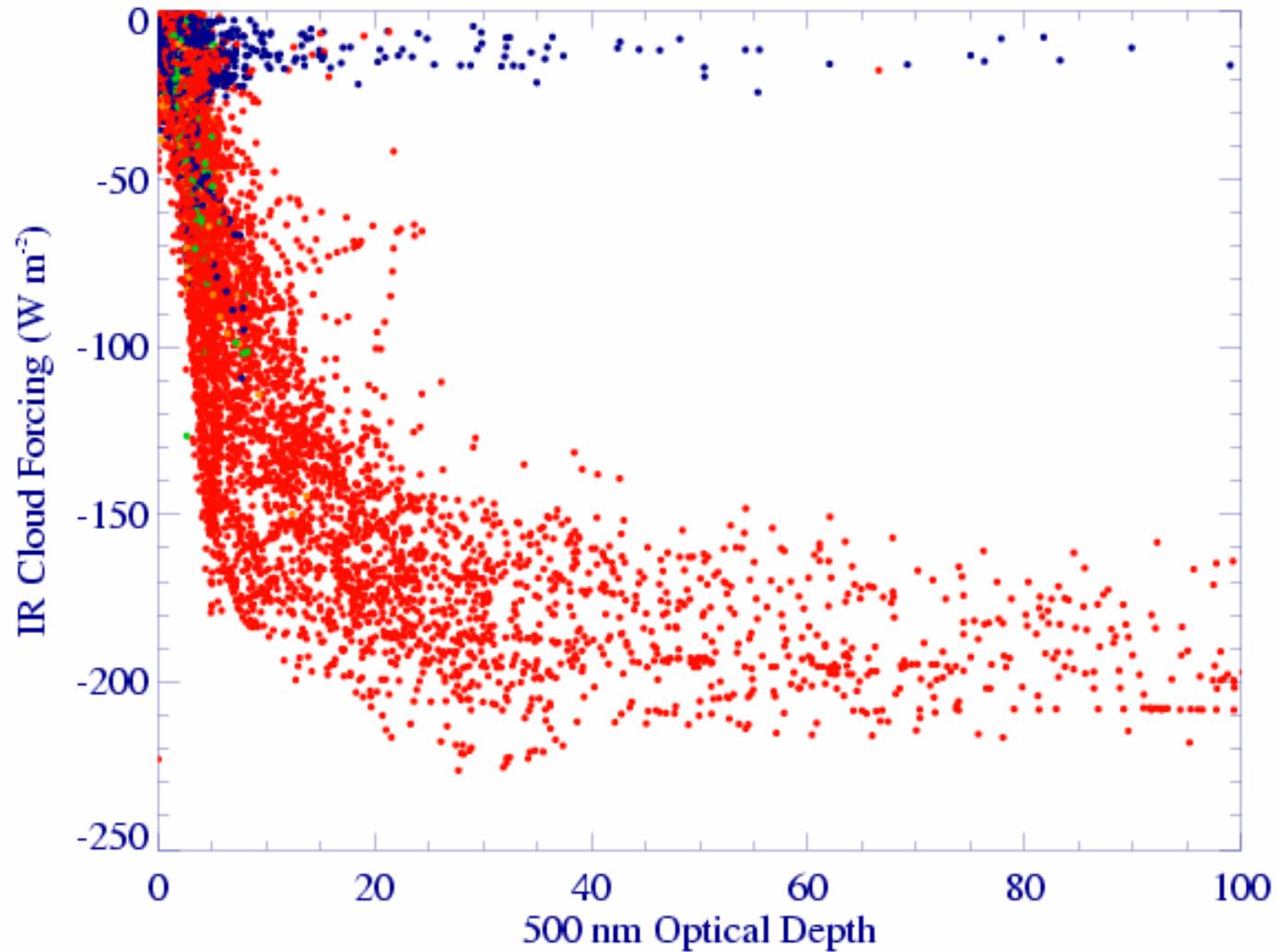
7/23/02: Net flux/Absorption



IR Forcing vs Albedo



IR Forcing vs τ



Summary

- Infrared fluxes consistent with CERES/CDC; MODTRAN?
 - ozone
 - surface temperatures
 - higher order corrections
- Cloud solar spectra:
 - strong ice signature; ice versus vapor absorption
 - forward model needs realistic g , ω_o
 - more case analyses
 - integrate microphysics/MAS
- Cloud forcing
 - Incorporate other data: lidar, microphysics
 - Derive heating/cooling profiles